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THE LANDSCAPE OF PRESBYOPIA-CORRECTING IOLS

BY ELIZABETH YEU, MD

Surgeons have been able to offer presbyopia-correcting intraocular lenses (PCIOLs) for well over a decade. However, only 7% of current cataract surgeries involved the use of PCIOLs, as assessed by the ASCRS 2017 survey of US surgeons,[1] presenting an opportunity to further educate surgeons and patients on the availability and benefits of PCIOLs. Monofocal IOLs provide clear distance vision but patients will require reading and/or computer glasses after cataract removal. PCIOLs offer the cataract and refractive surgeon an option to correct ametropia and presbyopia, thereby reducing patient dependence on spectacles following surgery.

Understanding the different types of PCIOLs and their different mechanisms of action is important to ensure proper patient selection and postoperative satisfaction. This article will provide a short overview of the various PCIOL technology options currently available in the United States.

Accommodating IOLs

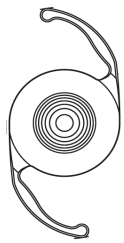
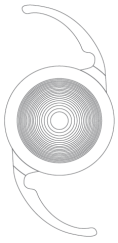
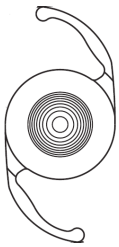
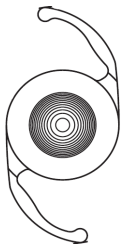
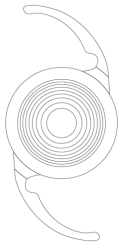
The first IOL labeled as accommodating, introduced to the US market in 2003, is a single-optic, plate haptic platform (Crystalens and Trulign, Bausch + Lomb). The design of this IOL is hypothesized to allow it to move anteriorly or posteriorly depending on the accommodative forces of the eye, thus providing distance and some intermediate vision. The single-optic accommodating IOL potentially has an advantage over other PCIOLs in regard to the visual quality perceived by the patient.[2] However, both near and intermediate vision are limited with this type of lens and this option has not been widely adopted.

Multifocal IOLs

The first multifocal IOL was launched in the United States in 2004. The light energy in a multifocal IOL is split into two focal points that are simultaneously presented to the retina. Different optical principles can be used to obtain two focal points: diffractive, refractive (which is no longer commonly used in the United States), and hybrid diffractive-refractive.[3] In the diffractive design, concentric rings with a small height bend the incoming light into the two focal points. In the hybrid diffractive-refractive platform, the lens typically has a diffractive central portion while the periphery is the refractive portion. The central portion may be apodized (ie, there is a gradual decrease in step height of the concentric rings from the center to the periphery) to redirect light energy to the distance focus in dim light conditions, thereby reducing optical phenomena. The peripheral refractive portion of the lens is intended to provide additional distance vision particularly in dim light. These IOLs are available in various add powers from low-add to high-add options (Table).

Multifocal IOLs with a higher add can provide clear near and far foci but in doing so may compromise intermediate vision. On the other hand, multifocal IOLs with lower-add power have fewer diffractive steps and can provide clear intermediate and far foci but may compromise near vision. Another

TABLE. MULTIFOCAL AND EXTENDED DEPTH OF FOCUS IOLS IN THE US MARKET.*

	High-add multifocal IOL		Multifocal IOLs		Low-add multifocal IOLs		EDOF IOL
Name	ReSTOR +4.0 D	TECNIS +4.0 D	ReSTOR +3.0 D	TECNIS +3.25 D	ReSTOR +2.5 D with Activefocus	TECNIS +2.75 D	TECNIS Symfony
							
Add Power (at the IOL Plane)	+4.0 D	+4.0 D	+2.5 D	+3.25 D	+2.0 D	+2.75 D	+ 1.75 D
Peak Near Performance	13 inches (33 cm)	13 inches (33 cm)	16 inches (40 cm)	16.5 inches (42 cm)	21 inches (53 cm)	20 inches (50 cm)	26 inches (66 cm)
Diffractive Steps	12 steps (Apodized)	22 steps	9 steps (Apodized)	18 steps	7 steps (Apodized)	15 steps	9 steps (referred to as echellettes)
Availability of toric technology	NO	NO	YES	NO	YES	NO	YES

*IOLs are not drawn to scale.

approach to achieve improved near vision with low-add multifocal IOLs is mini-monovision. This option targets the dominant eye for emmetropia and the nondominant eye for near vision by targeting -0.5 or -0.75 D. Lower-add multifocal lenses may have a lower halo profile than higher-add multifocal lenses and this has been shown in bench testing.[4]

Lower- and higher-add multifocal IOLs can be mixed and matched to tailor the patient's individual needs to provide near, intermediate and far vision, thereby maximizing functional vision. For example, a lower-add multifocal IOL can be implanted in the dominant eye to provide distance and intermediate vision, while the contralateral eye receives a higher-add multifocal IOL to provide distance and near vision.

Extended depth of focus IOLs

IOLs labeled as extended depth of focus (EDOF IOLs) entered the US market in 2016. The diffractive optic profile of these lenses is designed to split light into multiple foci, and an elongated focus area is created for increased depth of focus and a range of vision from distance to intermediate. EDOF IOLs currently available in the United States provide approximately +1.50 to +1.75 D of accommodative range.

The Future of PCIOLs

Trifocal IOLs are the newest addition to the global PCIOL landscape. They are not currently available in the US, but they represent an exciting opportunity to provide patients with a full and consistent range of vision from distance to near. In the trifocal platform, light energy is split into three focal points: (1) near; (2) intermediate; and (3) far. Generally, trifocals incorporate a diffractive optical design and can be apodized or nonapodized. These IOL designs have been widely adopted by surgeons and patients in the global IOL market due to the broad range of vision they offer.

I hope this short review of the PCIOL landscape, the IOLs available in the United States, and their mechanisms of action will help guide surgeons in proper patient selection and increase patient satisfaction.

1. 2017 Global Trends in Ophthalmology and the American Society of Cataract and Refractive Surgery. Supplement to *EyeWorld*. October 27, 2017.
2. Tomas-Juan J, et al. Single-optic positional accommodating intraocular lenses: a review. *Expert Rev Ophthalmol.* 2014;9(6):503-514.
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